# ON THE REPRODUCTION AND GROWTH OF THE
# SNOW SHEEP (OVIS NIVICOLA ESCH.)*

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Translated from Zoologicheskii Zhurnal XLI
(10): 1556-1566. 1962

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Translated for the Canadian Wildlife Service by G.J. Harder,
Canada Department of the Secretary of State, Bureau for
Translations

*Three illustrations in the original paper were not of suitable quality for reproduction and have been omitted from the translated version.

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# ON THE REPRODUCTION AND GROWTH OF THE SNOW SHEEP (*OVIS NIVICOLA* ESCH.)

The snow-sheep or bighorn (*Ovis nivicola* Esch.) is very com- on on the mountain ranges of North-Eastern Siberia. In a number f places it has been hunted of old. Regardless of this fact our iterature contains hardly any information on the biology of re- roduction of the snow sheep.

The material for this work was gathered by the author during xpeditions into the Koryak Highlands in 1959-1961, which lasted total of about 11 months. Some of the data obtained were pub- ished (Cherniavski, 1961). Besides personal observations, use as made of information gathered from Chukot hunters and reindeer reeders. Furthermore, use was made of the information in lit- rature on the reproduction of the American bighorn (*Ovis anadensis* Shaw), which, on the basis of biological characteristics, s fairly closely related to the Asiatic bighorns.[1]

It is known that the sex and age-class composition plays a rominent role in the reproductive processes of the species. able 1 contains data obtained as a result of a visual survey of he snow sheep through field-glasses, which was carried out by us rom May to September in 1960 and 1961.

1. Sex and age-class composition of the population of snow sheep ased on the data of the survey in the Koryak Highlands (1960-1961)

| Total | | Bighorns counted | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | of them | | | | | | | | | |
| | | Males above five years | | Males from 2 to 5 years | | Females | | Young ones up to 1 year | | Of last year | |
| No. | % | No. | % | No. | % | No. | % | No. | % | No. | % |
| 270 | 100 | 58 | 21.5 | 28 | 10.4 | 97 | 35.9 | 63 | 23.3 | 24 | 8.9 |
| 501 | 100 | 114 | 22.8 | 71 | 14.1 | 175 | 34.9 | 84 | 16.8 | 57 | 11.4 |
| 771 | 100 | 172 | 22.2 | 99 | 12.8 | 272 | 35.3 | 147 | 19.1 | 81 | 10.6 |

connection with this, five sex and age-class groups were set up: Males above the age of five years, 2) Males from 2 to 5 years, Adult females, 4) Young ones less than a year old, 5) Young ones the preceding year of both sexes. Under the conditions of a untainous country, when observing through 8-power-field-glasses, th some experience, these groups can be distinguished quite well. fficulties can occur only during the late fall months when trying distinguish, in mixed flocks, the almost grown yearlings from ult females. Those sheep encountered, of which the sex and age s not definitely determined, were not taken into consideration.

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These species are related also in the systematic aspect. V.I. Tsalkin (1951), for instance, unites them in the one species of *Ovis canadensis* Shaw.

It is advisable to divide the males into two groups for two reasons. Firstly, for a large part of the year, as already mentioned by us (Cherniavski, 1961), the flocks of males 5 years and over keep to themselves. Secondly, only this group of males actually participates in reproduction; for during the heat they drive the younger rams away from the females.

The ratio of females to males is presented in table 2. The mean number of females per male above the age of 5 years equals 1.6. If one, however, includes the males ranging in age from 2-4 years then the sex ratio will equal 1:1. It should be noted that hunting in those areas where we made a survey of the snow sheep, hardly affected the natural structure of the population. D.R. Smith(1954), who studied the ecology of bighorns in the state of Idaho, gives the ratio of males to females as 1:1.3. In the mountains of Colorado, according to C.C. Spencer(1943), the sex ratio of the bighorns was close to 1:1.

Three two-year-old ewes caught by us in summer had no lambs, but the three-year old ewes usually have an offspring. Apparently most snow-sheep ewes reach sexual maturity at the age of two years and lamb in the third year. R.F. Honess and N.M. Frost(1942) and also Spencer(1943) share the view that bighorn ewes below the age of 2.5 years do not participate in reproduction. Ewes, according to data by E. Seton(1929) and Smith(1954), can also become pregnant at the age of 1.5 years, but such cases are very rare.

e 2. Sex ratio in the population of snow sheep in the Koryak highlands according to data obtained by a visual survey.

| Indices | 1960 | 1961 | Total |
|---|---|---|---|
| Number of ewes | 97 | 175 | 272 |
| Total number of rams | 86 | 185 | 274 |
| Among them rams above the age of 5 years | 58 | 114 | 172 |
| Mean number of ewes per ram | 1.1 | 0.9 | 1.0 |
| Mean number of ewes per ram above the age of 5 years. | 1.7 | 1.5 | 1.6 |

The testicles of a ram slightly over two years old, which was obtained on August 29, 1961, were fairly resilient and reached a size of 9x4.4 cm. When dissected, sperm or semen flowed from the testis. Smith(1954) reports that a 1.5 year-old male bighorn which was kept in a flock of domestic sheep, attempted to mate with them in the middle of October. H.A. Ogren(1954), who made a detailed study of a bighorn population on a small island (Montana), reports a case where a two-year-old ram became a sire and the ewe which was covered by it produced a lamb. This shows that rams and ewes reach sexual maturity at about the same age.

The snow sheep on the Koryak highlands do not form permanent mixed flocks of adult rams and ewes even during the period

of heat. Groups of old rams move freely among the flocks of ewes and lambs in the vicinity of their habitat. This kind of contact with the ewes is maintained throughout the period of heat, but beginning in January the rams form their own flocks. V. Ch. Dorogostayski, based on reports by local hunters, pointed out that in the Stanovoy mountain range the rams and ewes form separate flocks in winter (Nasonov and Dorogostayski, 1915).. Data of this kind are also found in some works by American authors (Seton, 1929; Ogren, 1954; McCann, 1956.

Gathered information, and our own data on the dates of the lambing period, indicate that the peak of the period of heat in the Koryak highlands is reached during the latter part of December. The formation of "harems" of ewes by individual rams as reported by R.N. Meklenburtsev (1948) with respect to the Pamir bighorn (Ovis poli. Tr.) does not take place among snow sheep. More detailed descriptions of the heat exist for bighorns in the American part of their range (Mills, 1937; Spencer, 1943; Smith, 1954; Ogren, 1954; McCann, 1956).

There is a certain difference in the dates of the heat-period of wild sheep in the Soviet Union. Thus in Yakutia, according to reports by V.I. Kapitonov (personal report) and the data of R.G. Cheremkin (1959), the heat-period occurs in November. In the Norilsk mountains and on Kamchatka (Naumov, 1934; Averin, 1951) the heat-period lasts approximately from the middle of November to the middle of December. The dates of the heat-period are still later in the Koryak highlands.

e 3. The sociability of snow sheep ewes in May-June of 1961 (Koryak highlands)

| of mate | Number of individuals in a group | | | | | | | | Total number of cases | Total of animals counted |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | |
| | frequency of occurrence | | | | | | | | | |
| 15.VI | - | 3 | 3 | 5 | 4 | 2 | 1 | 1 | 19 | 82 |
| -31.VII | 10 | 4 | 2 | 1 | 4 | 2 | 2 | - | 25 | 73 |

Apparently this phenomenon coincides perfectly with the climatic conditions of the various areas. Spring comes later in the Koryak highlands than in Yakutia and if the mating season occurred in November lambing would occur in May, when it is still comparatively cold, and snow abounds.

According to our observations in May-June of 1961 in the upper reaches of the Vayega River (a tributary of the Mayn River, which joins the Anadyr River) the ewes congregate in small flocks of 2 to 8 head during the last months of the gestation period (table 3).

Barren ewes, and lambs of both sexes, can belong to these groups. At this time they feed primarily on southern slopes, travelling from one thawed patch to another, and rest on sections of bare fine talus or hillside scree from which the snow disappears earlier. A few days before lambing the ewes leave

the flock. During lambing and about a week after the event the ewes remain alone. Afterwards they again form small groups. In August the mixed herds or flocks can already have as many as 20 head.

The lambing of snow sheep in the Koryak highlands is quite a simultaneous process. In 1961 the mass-appearance of the young occurred during the last ten-day period in June. The peak of lambing coincided fairly closely with the beginning of the warm period, with the cessation of night-frosts, with the melting of about 80% of the snow in the mountains and with the appearance of new forage. The ewes lamb on practically inaccessible rocky slopes, primarily with a southern exposure. Here the outcrops of rocks border on grassy patches that are covered with herbaceous vegetation. In the upper reaches of the Vayega River the ewes at times withdraw for lambing into rocky canyons with walls 25-40 m. high, which were formed as a result of the cutting of the river-channel into the hard formations.

The snow sheep mostly bring forth one lamb. This is confirmed by our numerous observations and the collection of two pregnant ewes, each of which had one embryo. Each of 19 ewes dissected at the Kropotski sanctuary had one embryo. But twins are born too. We know of one perfectly reliable case when N.N. Pagolski, a geologist, obtained a ewe with two well-formed embryos. V.I. Kapitonov reported an analogous finding from the Kharaulakh mountains (Northern Yakutia). The ewes of the various forms of the American bighorns very rarely give birth to twins (Seton, 1925; Davis and Taylor, 1939; Buechner, 1960); Smith (1954), who made 215 observations, mentions only two cases of twins.

In connection with this it is interesting to note that in the other representatives of the genus Ovis-arkhars and mouflons-Ovis ammon poli and Ovis orientalis. Tr. twins are quite common (Carkisov, 1944; Antipin, 1947; Tsalkin, 1948). It is possible that the reduced fecundity of the snow sheep is a peculiar adaptation (for acute food shortage during winter ) and, in particular, during gestation. The literature at any rate contains reports that in the case of domestic sheep there occurs a selection for reducing fecundity during periodic famines; for, first of all, the females bearing twins perish (Stakan, 1947). I.I. Sokolov (1960) also regards the reduced fecundity of the Karakul desert sheep as an "adaptive reaction to unfavorable living conditions during gestation".

The lambs are well developed at birth. They can see, they are covered with thick wool and at the age of 2-3 days can follow the mother for short distances. Six sharp milk incisors and two canine teeth can be plainly seen in the mandible or lower jaw of newborn lambs. The remaining teeth are still concealed by a semi-transparent membrane.

The hoof-pads of the lambs during the first days of life are fairly soft; partly because the ewes with lambs stay on very

limited areas for 5-7 days after birth. At the age of one week the lamb can follow the mother for long distances over steep and rocky slopes. On June 29, 1961, I observed two suckling ewes with lambs not more than a week old on the edge of a rocky canyon. With the approach of a human being the ewes rushed for the main slope. They had to traverse a terrace about 400 m wide. The lambs kept up with the mothers on level ground and also on the rocky slope. The weight of newborn lambs ranges from 3 to 4.5 kg. A well developed male, which was removed from a six-year old ewe, on July 26, 1961, weighed 4 kg. Two other newborn lambs obtained by us, weighed 3.5 and 4 kg. A female, 2-3 days old, obtained by us in Yakutia, weighed 3.5 kg (V.I. Kapitonov, personal report). Ogren (1954) reports the weight of a newborn lamb as 4 kg. The dimensions of newborn lambs are presented in table 5.

The wool of the lambs is fine, fluffy and fairly thick. The wool on the back and on the sides is ash-grey. On the back, furthermore, occur many black guard hairs; this creates the impression of general mottled or speckled background. The head, neck, chest and front of both legs are dark-grey. There is a small white spot on the forehead. The back of the extremities, the belly, the groins and the rump are white. A narrow dark-brown stripe runs along the back. On the tail this stripe is practically black. The hooves are dark-brown; they are slightly yellowish in the lower part. The irises of the eyes are light-brown. The described colour of a lamb harmonizes or blends well with the generally dark-grey background of the rocks and talus. Apparently it is a protective colouration.

However, I have never observed in snow sheep lambs the concealment-instinct developed to such an extent as, for instance, in the ungulates of the open desert spaces (Sludski, 1956). From the age of about 7 days, as already mentioned above, the lambs escape danger by fleeing; following the mother.

The lactation period of snow sheep ewes is fairly long. I observed suckling in the latter part of September. F.M. Couey, (1950) encountered suckling ewes in the latter part of October (Montana). Nevertheless, there is no doubt that milk plays an important part in the ration or diet of lambs only during the first month of their lives. The frequency of suckling decreases considerably as the lambs grow older. On July 2, 1960, during a two hour observation period, a 2-3 day old lamb "used" the udder of the mother four times for 1-3 minutes. Larger lambs at times suckle by dropping on their "knees". Gradually the lambs ingest milk less and less frequently. This is facilitated also by the fact that at the age of about 10 days the lamb already begins to nibble at grass. The stomach of a month-old lamb obtained on June 21, 1960, contained 250 g of green feed. On July 28, 1961, during a four-hour observation of a flock with three lambs about a month old, no suckling was observed. On August 30, 1961, a large lamb tried to suckle, but it succeeded for only a few seconds.

At the age of 2-3 weeks the attachment of the lamb to its mother diminishes noticeably. In mixed flocks the lambs often prefer to stay with one another.

Our information concerning the barrenness of snow sheep ewes, nfortunately, is very scant and we are restricted to data based on visual census. From June 20 to July 10, 1961, i.e. during the eak of lambing activity and a short time later, 21 adult ewes[2] were ounted in the upper reaches of the Vayega River. This flock had 9 head with newborn lambs. Consequently, two ewes were barren, amely, about 10%. Similar figures based on dissections and observtions on the Kropotski preserve were obtained by Yu.V. Averin (1951). he relatively low infertility of ewes of the Koryak population oincides fully with the large relative number of adult rams in it see table 1). One cannot judge the extent of infertility by enounters with ewes with lambs in the second half of July and in ugust, since at this time the number of "single" ewes increases ue to death of the lambs. The census-figures for each month, comiled in table 4, indicate lamb-mortality during the first months f life.

e 4. Mortality rate of snow sheep lambs based on encounters with ewes with lambs on the Koryak Highlands (1960-1961)

| Month | Ewes encountered | | | | | |
|---|---|---|---|---|---|---|
| | with lamb | | without lamb | | total | |
| | No. | % | No. | % | No. | % |
| July | 60 | 75.9 | 19 | 24.1 | 79 | 100 |
| ugust | 38 | 61.3 | 24 | 38.7 | 62 | 100 |
| eptember | 31 | 55.4 | 25 | 44.6 | 56 | 100 |

These data show that lamb mortality proceeds fairly evenly and apparently by the end of September, about 30-35% of the lambs that were born have perished (with a correction for barrenness).

One of the causes of lamb mortality, especially during the first days after birth, can be inclement weather conditions, in particular, continuous rains accompanied by cold winds from the north. Further, there is no doubt that heavy losses are inflicted upon the lambs by predators--by wolverines and wolves, less frequently by lynxes, foxes and golden eagles (Aquila chrysaëtos).

The lambs that survived the winter, according to the census-data of 1960, comprised only 8.9% of the total number of sheep encountered (see table 1). In 1961 this figure amounted to 11.4%. Consequently, the loss of lambs during the first year of life is fairly heavy. In our opinion the basic causes of the losses of lambs are as follows: The harsh winter with a probable food shortage during the latter part, and the activity of predators.

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[2] Two-year-old, i.e. not yet sexually mature and barren ewes at this time can be fairly easily distinguished, through field-glasses, from ewes with lambs, by the extent of the shedding of the wool. The wool-shedding process of ewes with lambs, as is known, is greatly delayed.

A comparison of the linear dimensions[3] and the weight of rams of various ages, obtained by us on the Koryak Highlands, makes it possible to discuss certain peculiarities in the growth of bighorns under natural conditions. The data in Table 5 show that during the first months the lambs grow very rapidly. For examble, from the moment the lamb was born to the age of 2.5 months the length of the body increased by 47 cm, the height at the withers--by 35 cm, the circumference of the chest by 50 cm and the weight increased about five-fold. Such an intensive growth of the lambs undoubtedly is of adaptive significance and is peculiar, it seems, to all mountain ungulates. This phenomenon has been studied by O.V. Egorov (1953), on the basis of abundant material, in relation to the wild goat of Siberia Capra sibirica. Tr. . Of course, in winter the growth-rate is sharply reduced. During the 9 fall, winter and early spring months, height at the withers increased by only 5 cm and weight by 3 kg. During the second summer the year-old lamb grows, although less intensively than during the first summer; but the growth is quite noticeable. This is shown by a comparison of the indices of rams 12 and 14 months old. During two summer months (July-August) the length of the body increased by 8 cm and the weight by 9 kg.

With increasing age the growth-rate slows down, but the sheep continue to grow till the age of 9-10 years.

One of the most striking peculiarities of the build of newborn lambs is their relatively long legs. The ratio of the oblique length of the body to the height of the anterior extremity in the ulnar joint of newborn lambs equals 1.16-1.20 whereas in adult rams the value of this relation, on the average, equals 1.66 (for 9 specimens). However, due to the fact that the body grows somewhat faster than the extremities, young rams a few months after birth have already acquired the characteristic (body form) of adult rams. Thus at the age of 1.5 months the above index equals 1.42 and in a 14-month-old ram it equals 1.61, i.e. it approximates the indices of adult animals.

The literature contains no information on dates and order of development of the dentition of the snow sheep. Such data, it is known, can serve as a basis for an accurate determination of the age of the animals, which is of great practical significance. This is all the more important since it is impossible to determine the age of snow sheep ewes by the horns because they lack a distinct annual segmentation. A collection of skulls of snow sheep in the Zoological Institute of the Academy of Sciences, USSR., and our own collections from the Koryak Highlands served as material to describe the changes in the dentition of snow sheep attributable to age. A total of 46 skulls was examined. When processing this material the methods used earlier by I.I. Sokolov for analogous purposes, were used.

The study of changes in the dentition was made primarily in connection with rams; for this makes it possible to determine accurately the age of the animals by the number of the annual segmentations on

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[3] The measuring methods of I.I.Sokolov (1959)

Table 5
Linear dimensions (in centimeters) and weight (in kilograms) of snow sheep rams varying in age (13 specimens from the Koryak highlands)

| Weight and dimensions | Age | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | New lamb | 2-4 days | 1 mo. | 1.5 mo. | 2.5 mo. | 12 mo. | 14 mo. | 26 mo. | 3 years | 4 years | 6 yrs | 10 yrs | 14 yrs |
| Weight | 4.0 | 4.5 | 7.5 | 9 | 20 | 23 | 32 | 40 | 55.3 | 61 | 74 | 76 | 70 |
| Length of body | 61 | 64 | 83 | 92 | 108 | 114 | 122 | 134 | 141 | 145 | 149 | 151 | 148 |
| " of head | 16 | 21 | 22 | 24 | 28 | 29 | 31 | 41 | 43 | 44 | 45 | 45 | 43 |
| " of foreleg | 29 | 30 | 35 | 40 | 46 | 48 | 49 | 53 | 56 | 56 | 57 | 57.5 | 55 |
| " of hock | 18 | 18 | - | 25 | 26 | 29 | 30 | 32 | 32 | 32 | 33 | 32 | 31 |
| " of foot | 22 | 23 | 25 | 30 | 34 | 36 | 37 | 39 | 40 | 40 | 41 | 40 | 39 |
| " of pelvis | 12 | 13 | 17 | 19 | 24 | 25 | - | 32 | 31 | 32 | 31 | 33 | 32 |
| " of tail | 3.5 | 5 | 8.5 | 9 | 10 | 9.5 | 9 | 10 | 10 | 10.5 | 11 | 11 | 10 |
| " of ear | 5.7 | 6 | 6 | 7.5 | 8 | 8 | - | 8 | 9 | 8 | 9.5 | 9.5 | 9 |
| Oblique length of body | 35 | 35 | 52 | 57 | - | 75 | 79 | - | 94 | 97 | 96 | 97.5 | 97 |
| Height at withers | 44 | 48 | 55 | 62 | 79 | 84 | 85 | 89 | 96 | 98 | 100 | 99 | 96 |
| Girth of chest | 41 | 44 | 53 | 62 | 91 | 86 | 91 | 96 | 101 | 115 | 106 | 111 | 103 |
| " of foreleg | - | 5 | - | 7.5 | 8 | 8.5 | - | - | 10 | - | 11 | 10.5 | 10.5 |
| Width of shoulders | - | 13 | 16 | 17 | - | 23 | 24 | - | 30 | - | 29 | 31 | 29 |
| " of pelvis | - | 12 | 15 | - | 17 | 20 | - | 27 | - | - | 30 | 27 | 26 |

the horns. However, a study of the skulls of ewes of about the same age (up to 2 years) running parallel to a study of the skulls of rams shows that in regard to the development of the dentition, there exists a complete synchrony in both sexes. The same phenomenon was observed for the roe deer (Capreolus capreolus. Tr.) and the saiga (Saiga Tatarica. Tr.) (Sokolov, 1956; Sokolov and Rashek, 1961).

The post-embryonic development of the dentition of the snow sheep takes place in the following manner:

Newborn lambs(3)[4]. They have all the milk incisors, canine teeth and the premolars. But the premolars are still covered with a thin mucous membrane, which disappears within a few days after birth. In the prepared skulls one can see, deep down in the osseous alveoli of the maxilla and the mandible, the tips of the first molars ($M^1$ and $M_1$) which are being formed.

One month (2). The tips of the first molars in the maxilla and in the mandible have reached the level of the alveoli. Wear can be observed on the posterior part of the second milk premolar in the mandible ($Pd_3$).

Two months (1). The first molars ($M^1$ and $M_1$) emerge from the alveoli and the tips and anterior edges have just cut through the mucous membrane. The wear of all the milk premolars is readily seen, the front premolar of the mandible being an exception ($Pd_2$). Wear of the anterior pair of milk incisors sets in ($Id_1$).

Three months (5). The edges of the second and third pair of milk incisors (Id1, Id2) wear off. The milk premolars are worn down more than those of two-month-old lambs.

Seven-eight months (1). The first molars are fully developed. On the lower ones (M) both cusps are worn off and in the upper one ($M^1$) only the anterior cusp is worn off. The second molars ($M^2$ and $M_2$) are being formed in the alveoli or sockets. The front cusp of the first milk premolar in the mandible ($Pd_2$) is worn off. The infundibulae or pits on the first upper ($Pd^2$) and second lower ($Pd_3$) milk premolars wear away and disappear. Wear is readily noticeable on all the milk incisors ($Id_1$-$Id_3$) and on the canine teeth (Cd).

One year (3). The second molars emerge from the alveoli; only the front cusps of the upper ($M^2$) and lower (M2) ones cut through the mucous membrane. The posterior cusps of the first upper molars wear off. On the third lower premolars ($Pd_3$) the front infundibulae wear away. The first pair of incisors ($I_1$) is being replaced.

Two years (4). The second molars ($M_2$ and $M_2$) reach full development. The front and back cusps of $M_2$ wear off, the back cusps of $M^2$ also wear down, but the wear is barely noticeable. The cusps of

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[4] Here and below the number of examined skulls is indicated in brackets.

the third molars ($M^3$ and $M_3$ ) emerge above the level of the upper edges of the alveoli, but have not yet cut through. Down in the jaws, below the milk teeth, one can see the developing dental crowns of the permanent premolars. The first pair of milk incisors is replaced by permanent ones ($I_1$). The replacement of the 2nd pair of incisors is taking place ($I_2$).

Two years and three months (1). The anterior edges of the third molars ($M_3$ and $M^3$) have cut through the mucous membrane. The wear of the front and posterior cusps of the middle molars ($M_2$ and $M^2$) is readily noticeable. The deciduous pre-molars of both jaws drop out. The permanent premolars ($P^{2-4}$and $P_{2-4}$) rise above the level of the upper edges of the alveoli, but have not yet shed the mucous membrane. The second pair of incisors ($I_2$) is now fully replaced.

Two years and nine months (1). The second cusps of the last lower molars have cut through and their anterior cusps are wearing down. The talonids have not yet come through, although they have emerged above the edge of the alveoli. The anterior cusps of the last upper molars ($M^3$) come through. The permanent premolars in the mandible have not yet reached the level of the adjoining molars. In the mandible, $P_3$ and $P_4$ have reached the level of $M_1$ and wear is setting in. The third pair of incisors ($I_3$) is being replaced.

Three years and two months (2). The anterior and posterior cusps of the last molars in the mandible ($M_3$) also begin to wear down. In the last molars of the maxilla ($M^3$) only the anterior cusps wear off. The permanent premolars (with the exception of $P^2$) in both jaws have reached the level of the entire row of teeth. The outside cusps of their second ($P^3$) and third ($P^4$) pairs in the upper jaw begin to wear off. The third pair of incisors ($I_3$) is replaced, but has not yet reached the level of the adjoining teeth. The crowns of $I_1$ and $I_2$ are noticeably worn.

Three years and five months (1). The posterior cusps of $M^3$ are not yet showing any signs of wear. The second pre-molars of the mandible ($P_3$) are worn primarily in the posterior half. The deciduous canine teeth (Cd) have not yet dropped out.

Three years and nine months (1). The outside parts of the posterior cusps of the posterior molars of the maxilla ($M^3$) begin to wear off. Due to detrition or wear the "fissures" between the alveolae of the front upper ($M^1$) and the lower front ($M_1$) molars are closed. The permanent canine teeth (C) protrude slightly beyond the edges of the osseous alveoli.

Four years and five months (1). The formation of the dentition is complete--the permanent canine teeth (C) have reached the level of the entire row of teeth. The outside edge of talonid $M^3$ is beginning to wear off. The third pair of incisors ($I_3$) is also showing signs of wear.

Five years (2). The talonids and all the cusps of the upper last molars ($M^3$), including the inside posterior one, are wearing off. Wear of the first premolar of the mandible ($P_2$) is setting in. Both

cusps of the second premolar of the mandible ($P_3$) are wearing off. The canine teeth (C) show little wear (at times it has not yet set in).

Five years and six months (2). The canine teeth (C) are noticeably worn. The infundibulae on the anterior molars of the maxilla are closing ($M^1$).

Six years (2). At times the front upper premolars ($P^2$) lack infundibulae by reason of wear.

Seven years (3). The infundibulae on the anterior cones of the first molars of the lower jaw ($M_1$) disappear. Infundibulae are lacking on the second lower premolars ($P_3$) and also on the posterior cones of the third lower premolars ($P_4$). The infundibulae remain open only on the last upper molars ($M^3$).

Eight years (3). The front molars of the lower jaw ($M_1$) lack infundibulae on both cones. The incisors are worn to such an extent that their crowns grow narrow and chisel-shaped.

Ten-eleven years (3). The infundibulae on all the upper premolars ($P^2$-$P^4$) wear away and on the lower ones ($P_2$-$P_4$) only points remain in their stead. The anterior infundibulae on $M^1$ disappear.

Twelve years (4). Only the roots protruding from the alveoli remain of the incisors and the canine teeth. In most cases the anterior and posterior infundibulae are lacking on the second lower premolars ($M_2$ . The anterior infundibulae can disappear on the second upper ($M^2$) and on the third lower molars ($M_3$). The "fissures" or spaces between the infundibulae on the last molars of the upper jaw close.

Fourteen years (1). This age is close to the age limit. The incisors and canine teeth drop out.[5] All the teeth in the lower jaw lack infundibulae. The anterior infundibulae on $M^2$ disappear. The crowns of all premolars are almost completely worh off.

Thus the dental system of snow sheep is completely formed at the age of four years; the canine teeth are the last to be replaced. The fact, noticed by V.I. Tsalkin (1951), that the wear of the teeth of snow sheep is less intense than in the other representatives of the genus Ovis, is of interest.

On the basis of a study of the dentition of snow sheep it can be assumed that the age of 14-15 years under natural conditions is the limit; for at this time the teeth are completely worn down. I. Cowan (1940), who examined a series of 761 skulls of American bighorns, found among them only two skulls of males 15-17 years old. According to data of Seton (1929), a bighorn ram in the Washington zoo lived to the age of 20 years; apparently the fact that the animal was kept in captivity played an important role in this case.

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[5] This was noticed in the skull of an animal just killed.

## CONCLUSIONS.

1. The sex ratio in snow sheep populations, not exposed to the effect of hunting, is close to 1:1.

2. Most ewes and rams attain sexual maturity at the age of two years, but as an exception, 1.5 year old rams can participate in reproduction.

3. The rut lasts about one and a half months. In the Koryak highlands it occurs in December and the early part of January. In other parts of the range the dates of the rut vary. The rut is determined by the lambing dates in relation to the weather, since the gestation-period is very constant (about 180 days).

4. The birth of snow sheep lambs coincides with the approach of relatively warm weather, with the disappearance of most of the snow from the slopes and appearance of fresh pasturage. The peak of lambing in the Koryak highlands is in the latter part of June.

5. Certain peculiarities of the reproductive biology of the snow sheep can be regarded as adaptations of the species to an existence under the harsh conditions of the mountain tundras of the North-East. The following should be numbered among them:
 a) The timing of lambing with the approach of the warm season;
 b) Bearing well-developed lambs, which, at the age of one week, can follow the ewe over rocky slopes for considerable distances;
 c) The capacity of the lambs, already at the age of one month, to get along without milk and to feed upon grass;
 d) The exceptionally rapid growth of the lambs during the first months after birth.

6. A relatively low fecundity, regardless of the insignificant percentage of barren ewes in isolated cases is characteristic of the snow sheep, for, as a rule, only one lamb is born. The mortality rate of the young by the end of September, according to our data, is about 30% in the Koryak highlands. During the first year of life about 50% of all the lambs that were born are lost. Because of this the annual increase of the flock is small.

7. The slow increase in the number of snow sheep is reflected by the relatively small numerical strength of the animal, which, for instance, was noticed in the Koryak highlands even in areas not frequented by hunters (Cherniavski, 1961).

8. The problem of the scope or extent of hunting of the snow sheep must be approached cautiously and census data must be taken into consideration in each case. In the Koryak highlands, for instance, the local people are at present permitted to engage in the licenced killing of adult rams. The best hunting period is from October 1 to November 15.

9. The dentition of snow sheep is completely formed by the age of four years. The teeth wear down in 14-15 years; this is the maximum age of snow sheep.

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AUTHOR

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